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(54) **ELECTRIC POWER CONVERTER**

ELEKTRISCHE LEISTUNGSWANDLER

CONVERTISSEUR ÉLECTRIQUE

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(73) Proprietor: **LG Energy Solution, Ltd.**

Seoul 07335 (KR)

(72) Inventor: **KIM, Byeong Geon**

Daejeon 34122 (KR)

(74) Representative: **Goddar, Heinz J.**

Boehmert & Boehmert

Anwaltpartnerschaft mbB

Pettenkoferstrasse 22

80336 München (DE)

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Description

Technical Field

[0001] The present disclosure relates to a DC-DC (direct current-direct current) converter.

Background Art

[0002] The DC-DC converter converts an input voltage and supplies an output voltage having a required voltage level. In the DC-DC converter, a transient voltage may be generated according to voltage switching. A snubber circuit may be applied to the DC-DC converter to prevent component damage due to transient voltage and to remove EMI radiation noise.

[0003] In order to remove noise, it is necessary to optimize the snubber circuit by changing and designing a snubber value such as resistance and capacitance of the snubber circuit, and when the snubber circuit is embedded in an IC device, it is difficult to change the snubber value of the snubber circuit unless the IC device is replaced.

[0004] US 2020/0395842 A1 discloses a voltage regulator circuit designed to attenuate ringing in the switch node of a buck converter. The voltage regulator includes high-side and low-side field-effect transistors (FETs), an inductor, and a conductive net connecting these components. An attenuation circuit, which includes an electronic switch, is coupled to the conductive net to control the amount of attenuation. The switchable snubber circuit is turned on by the controller to attenuate voltage spikes when needed, thereby reducing power dissipation during normal operation. The controller monitors the voltage or current and activates the snubber circuit when the measured values exceed set thresholds.

[0005] US 2020/0204062 A1 discloses a snubber circuit, a control circuit, and an information processing apparatus aimed at reducing noise in circuits with switching elements, such as converters or inverters. The snubber circuit includes a first capacitor and a first resistor with a variable resistance value, which can be controlled by a control circuit. The information processing apparatus can measure radiation noise and adjust the resistance value of the snubber circuit based on the acquired noise information. The snubber circuit can also include multiple resistors and capacitors, with switching elements to vary their connections, further enhancing noise reduction capabilities.

Technical Problem

[0006] In a DC-DC converter including a snubber circuit, when the snubber circuit is embedded in an IC device, a DC-DC converter capable of variably applying a snubber value is provided.

Technical Solution

[0007] The invention is defined by the subject matter of the independent claims. Advantageous embodiments are subject to the dependent claims.

[0008] According to an embodiment of the invention, an electric power converter includes an integrated circuit including at least one power transistor and a snubber circuit connected in parallel to the at least one power transistor, and a selection resistor connected between a power supply voltage supplied to the integrated circuit and the snubber circuit, in which the snubber circuit includes at least two snubbers, and each of the at least two snubbers includes a resistor, a first transistor, and a capacitor connected in series, and the selection resistor is connected to a gate of the first transistor of any one of the at least two snubbers. The electric power converter further comprises a resistance box circuit. The resistance box circuit comprises, for each snubber, an individual resistance box connected to a gate of the first transistor of any the respective one of the at least two snubbers and to a power supply voltage (VCC) through selection terminals of the integrated circuit. At least one of the individual resistance boxes for the snubbers includes a selection resistor. Each selection resistor connects the gate of the transistor of the snubber corresponding to the respective individual resistance box to the power supply voltage (VCC) thereby turning on the transistor of said snubber corresponding to the respective individual resistance box.

[0009] The first transistor of any one of the at least two snubbers may be turned on by the power supply voltage supplied through the selection resistor.

[0010] The first transistor of the remaining snubber except any one of the at least two snubbers may be turned off.

[0011] The integrated circuit may further include a switch control circuit configured to receive the power supply voltage and control a switching operation of the at least one power transistor.

[0012] According to another embodiment of the invention, there is provided an electric power converter including: an integrated circuit including at least one power transistor and a snubber circuit connected in parallel to the at least one power transistor; and at least two selection resistors connected between a power supply voltage supplied to the integrated circuit and the snubber circuit, in which the snubber circuit includes at least two resistors, at least two first transistors connected in series to the at least two resistors, respectively, at least two capacitors, and at least two second transistors connected in series to the at least two capacitors, respectively. The electric power converter further comprises a resistance box circuit comprising a plurality of individual resistance boxes for the snubber circuit. Each of the individual resistance boxes is connected to either a gate of one of the first transistors and to a power supply voltage (VCC) through selection terminals of the integrated circuit.

cuit, or to a gate of one of the second transistors and to the power supply voltage (VCC) through the selection terminals. At least two of the individual resistance boxes for the snubber circuit include a selection resistor. Each selection resistor connects either the gate of one of the first transistors or the gate of one of the second transistors to the power supply voltage (VCC) through the selection resistor of the respective individual resistance box to thereby turn on the respective first transistor or the respective second transistor. A first selection resistor of the at least two selection resistors is connected to the gate of one of the first transistors connected in series to any one of the at least two resistors, and a second selection resistor of the at least two selection resistors is connected to the gate of one of the second transistors connected in series to any one of the at least two capacitors.

[0013] A first transistor connected in series to any one of the at least two resistors may be turned on by the power supply voltage supplied through the first selection resistor, and a second transistor connected in series to any one of the at least two capacitors may be turned on by the power supply voltage supplied through the second selection resistor.

[0014] The first transistor connected in series to the remaining resistors except any one of the at least two resistors may be turned off, and the second transistor connected in series to the remaining capacitors except any one of the at least two capacitors may be turned off.

[0015] The integrated circuit may further include a switch control circuit configured to receive the power supply voltage and control the at least one power transistor.

[0016] The at least two selection resistors may include a third selection resistor that may be connected to a gate of a first transistor connected in series to another of the at least two resistors, and a resistance value of the snubber circuit may be a parallel synthesis resistance of one of the at least two resistors and another resistor.

[0017] The at least two selection resistors may include a third selection resistor that may be connected to a gate of a second transistor connected in series to another of the at least two capacitors, and a capacitance value of the snubber circuit may be a parallel synthesis capacitance of one of the at least two capacitors and another capacitor.

[0018] The electric power converter may be a DC-DC converter.

Advantageous Effects

[0019] According to the present disclosure, in a DC-DC converter including a snubber circuit, when the snubber circuit is embedded in an IC device, a DC-DC converter capable of selectively configuring a snubber circuit among a plurality of snubbers or variably applying a resistance value and a capacitance of the snubber circuit may be provided.

Description of the Drawings

[0020]

FIG. 1 is a block diagram schematically illustrating a converter according to an exemplary embodiment. FIG. 2 is a circuit diagram illustrating an example of implementing a snubber circuit and a resistance box according to an exemplary embodiment.

FIG. 3 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

FIG. 4 is a circuit diagram illustrating an example of implementing a snubber circuit and a resistance box according to an exemplary embodiment.

FIG. 5 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

FIG. 6 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

FIG. 7 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

Mode for Invention

[0021] Hereinafter, exemplary embodiments disclosed in the present specification will be described in detail with reference to the accompanying drawings, in which the same or similar components are given the same or similar reference numerals, and redundant descriptions thereof will be omitted. In the following description, the suffix "module" and/or "unit" for the constituent elements are given or mixed in consideration of the ease of description only, and do not have meanings or roles that are distinguished from each other. In addition, in describing the exemplary embodiments disclosed in the present specification, when it is determined that the detailed description of the related known technology may obscure the gist of the exemplary embodiments disclosed in the present specification, the detailed description thereof will be omitted. In addition, the accompanying drawings are merely provided to easily understand the exemplary embodiments disclosed in the present specification.

[0022] Terms including ordinal numbers such as first, second, etc. may be used to describe various elements, but the elements are not limited by the terms. The terms are used only for the purpose of distinguishing one component from another component.

[0023] In the present application, it should be understood that the term "include" or "have" indicates that a feature, a number, a step, an operation, a component, a part, or a combination thereof described in the specification is present, but does not exclude the possibility of presence or addition of one or more other features, numbers, steps, operations, components, parts, or combinations thereof in advance.

[0024] FIGS. 1 to 7 illustrate a converter circuit for converting an input DC voltage into a DC voltage, which allows a snubber circuit to be variously configured.

[0025] FIG. 1 is a block diagram schematically illustrating a converter according to an exemplary embodiment.

[0026] The converter 1 may DC-DC-convert an input voltage V_{in} and output an output voltage V_{out} . The converter 1 includes an integrated circuit (IC) 10, a resistance box 20, and an output unit 30. The converter 1 may be mounted on a printed circuit board (PCB).

[0027] The power supply voltage V_{CC} may be supplied to the IC 10 through the terminal P1, and the power supply voltage V_{CC} is supplied to the resistance box 20.

[0028] The input voltage V_{in} may be supplied to the IC 10 through the terminal P2. The IC 10 may DC-DC-convert an input voltage V_{in} and transmit an output voltage to the output unit 30 through a terminal P4 and a terminal P5. The input voltage V_{in} may be connected to the terminals P2 and P3.

[0029] The resistance box 20 selects a configuration of the IC 10 through the plurality of selection terminals P11 to P13. Although FIG. 1 illustrates that the IC 10 includes three selection terminals P11 to P13, the disclosure is not limited thereto, and the IC 10 may be implemented to include two or more selection terminals.

[0030] The IC 10 may convert an input voltage through a plurality of transistors and a switch control circuit. The IC 10 may include a switch control circuit 110, a first power transistor Q1, a first resistor R1, a first capacitor C1, a second power transistor Q2, a snubber circuit 120, and an inductor L.

[0031] The switch control circuit 110 may generate transistor control signals QCS1 and QCS2 for controlling switching operations of the first and second power transistors Q1 and Q2 by using the power supply voltage V_{CC} input through the terminal P1 as a power source. Switching operations of the first power transistor Q1 and the second power transistor Q2 may be controlled according to transistor control signals QCS1 and QCS2 supplied from the switch control circuit 110.

[0032] The first resistor R1 and the first capacitor C1 are connected to each other in series, and are connected to the first power transistor Q1 in parallel. One end of the first power transistor Q1 is connected to one end of the switch control circuit 110. The other end of the first power transistor Q1 is connected to a node to which one end of the second power transistor Q2, a terminal P21 of the snubber circuit 120, and one end of the inductor L are connected. The other end of the second power transistor Q2 is connected to a node to which the other end of the switch control circuit 110 and the terminal P22 of the snubber circuit 120 are connected. Terminal P23 of snubber circuit 120 is connected to terminal P5 of IC 10. The other end of the inductor L is connected to a terminal P4, and a terminal P23 of the snubber circuit 120 is connected to a terminal P5.

[0033] The output unit 30 may include a capacitor C and a load R. In the output unit 30, one end of the output

voltage V_{out} is connected to a node to which one end of the capacitor C and one end of the load R are connected, and the other end of the output voltage V_{out} is connected to a node to which the other end of the capacitor C and the other end of the load R are connected.

[0034] The on-level of the transistor control signals QCS1 and QCS2 is a high level, and the off-level thereof is a low level. When the first power transistor Q1 is turned on and the second power transistor Q2 is turned off by the transistor control signal QCS1 of the high level and the transistor control signal QCS2 of the low level, the input voltage V_{in} is supplied to the inductor L so that the current flowing through the inductor L may increase. When the first power transistor Q1 is turned off and the second power transistor Q2 is turned on by the transistor control signal QCS1 of the low level and the transistor control signal QCS2 of the high level, the current flowing through the inductor L may decrease while flowing through the second power transistor Q2. A current flowing through the inductor L may be supplied to the load R, and the output voltage V_{out} may be smoothed to a constant level by the capacitor C. The switch control circuit 110 may sense the output voltage V_{out} and may control switching operations of the first and second power transistors Q1 and Q2 so that the output voltage V_{out} may be maintained at a predetermined level.

[0035] Hereinafter, the operation of the snubber circuit 120 according to the internal circuit configuration of the resistance box 20 will be described with reference to FIGS. 2 and 3.

[0036] FIG. 2 is a circuit diagram illustrating an example of implementing a snubber circuit and a resistance box according to a first embodiment of the invention.

[0037] The snubber circuit according to an example illustrated in FIG. 2 is configured to operate in a snubber unit in which a resistor, a capacitor, and a transistor are connected in series.

[0038] The snubber circuit 120 includes a first snubber 121, a second snubber 122, a third snubber 123, and a plurality of gate resistors RG21 to RG23. The first snubber 121 includes a resistor R21, a capacitor C21, and a transistor Q21, the second snubber 122 includes a resistor R22, a capacitor C22, and a transistor Q22, and the third snubber 123 includes a resistor R23, a capacitor C23, and a transistor Q23.

[0039] Although FIG. 2 illustrates that the snubber circuit 120 includes three snubbers 121 to 123, the present disclosure is not limited thereto, and the snubber circuit 120 may be implemented as including two or more snubbers. As illustrated in FIG. 2, the number of selection terminals P11 to P13 may be increased or decreased based on the number of snubbers included in the snubber circuit 120.

[0040] One end of the first snubber 121, one end of the second snubber 122, and one end of the third snubber 123 are connected to a terminal P21, and the other end of the first snubber 121, the other end of the second snubber 122, and the other end of the third snubber 123 are

connected to a node to which the terminal P22 and the terminal P23 are connected.

[0041] The terminal P21 is connected to a node to which one end of the resistor R21, one end of the resistor R22, and one end of the resistor R23 are connected.

[0042] The other end of the resistor R21 is connected to one end of the transistor Q21. The other end of the transistor Q21 is connected to one end of the capacitor C21. One end of the gate resistor RG21 is connected to the gate end of the transistor Q21, and the other end of the gate resistor RG21 is connected to the selection terminal P11.

[0043] The other end of the resistor R22 is connected to one end of the transistor Q22. The other end of the transistor Q22 is connected to one end of the capacitor C22. One end of the gate resistor RG22 is connected to the gate end of the transistor Q22, and the other end of the gate resistor RG22 is connected to the selection terminal P12.

[0044] The other end of the resistor R23 is connected to one end of the transistor Q23. The other end of the transistor Q23 is connected to one end of the capacitor C23. One end of the gate resistor RG23 is connected to the gate end of the transistor Q23, and the other end of the gate resistor RG23 is connected to the selection terminal P13.

[0045] The other end of the capacitor C21, the other end of the capacitor C22, and the other end of the capacitor C23 are connected to the node to which the terminal P22 and the terminal P23 are connected.

[0046] The snubber circuit 120 according to the exemplary embodiment illustrated in FIG. 2 operates through at least one selected from among the first snubber 121, the second snubber 122, and the third snubber 123 according to the configuration of the resistance box 20.

[0047] The resistance box 20 includes a plurality of individual resistance boxes 21 to 23. In FIG. 2, the resistance box 20 is illustrated as including three individual resistance boxes 21 to 23, but the present disclosure is not limited thereto, and the resistance box 20 may be implemented as including two or more individual resistance boxes. The number of individual resistance boxes may be increased or decreased based on the number of selection terminals P11 to P13.

[0048] Each of a plurality of individual resistance boxes 21 to 23 may include a selection resistor. Alternatively, each of a plurality of individual resistance boxes 21 to 23 may be an open circuit. Hereinafter, a resistance box that does not include the selection resistor among the plurality of individual resistance boxes 21 to 23 will be described as being open.

[0049] Hereinafter, an exemplary embodiment of the individual resistance boxes 21 to 23 included in the resistance box 20 will be described with reference to FIG. 3.

[0050] FIG. 3 is a circuit diagram illustrating an example of a resistance box according to an exemplary em-

bodiment.

[0051] In the example of FIG. 3, the selection resistor RS1 is included in the individual resistance box 21, and the selection resistor is not included in the remaining individual resistance boxes 22 and 23.

[0052] The power supply voltage VCC supplied to the resistance box 20 may supply a current to a corresponding selection terminal (e.g., P11) among the plurality of selection terminals P11 to P13 through an individual resistance box (e.g., 21) including a selection resistor among the plurality of individual resistance boxes 21 to 23.

[0053] In the converter 1 using the snubber circuit 120 and the resistance box 20 of FIGS. 2 and 3, the transistor Q21 is turned on by the power supply voltage VCC supplied through the resistor RS1 and the resistor RG21. When the transistor Q21 is turned on, the first snubber 121 is connected in parallel to the second power transistor Q2. That is, the first snubber 121 may operate with respect to a transient voltage that may occur during a switching operation of the second power transistor Q2.

[0054] When the transistor Q21 is turned on, the resistance value of the snubber circuit 120 may be the resistance value of the resistor R21, and the capacitance of the snubber circuit 120 may be determined as the capacitance of the capacitor C21.

[0055] Hereinafter, an operation of the snubber circuit 120 according to an internal circuit configuration of the resistance box 20 capable of controlling a resistor and a capacitor of the snubber, respectively, will be described with reference to FIGS. 4 to 7.

[0056] FIG. 4 is a circuit diagram illustrating an example of implementing a snubber circuit and a resistance box according to a second embodiment of the invention.

[0057] The snubber circuit according to an exemplary embodiment illustrated in FIG. 4 may not operate in a snubber unit, unlike the snubber circuit according to an exemplary embodiment illustrated in FIG. 2.

[0058] The snubber circuit 120 includes a plurality of resistors R21 to R23, a plurality of capacitors C21 to C23, a plurality of transistors Q21 to Q23, Q211, Q221, and Q231, and a plurality of gate resistors RG21 to RG23, RG211, RG221, and RG231.

[0059] The terminal P21 is connected to a node to which one end of the resistor R21, one end of the resistor R22, and one end of the resistor R23 are connected.

[0060] The other end of the resistor R21 is connected to one end of the transistor Q21. One end of the gate resistor RG21 is connected to the gate end of the transistor Q21, and the other end of the gate resistor RG21 is connected to the selection terminal P11. One end of the transistor Q211 is connected to one end of the capacitor C21. One end of the gate resistor RG211 is connected to the gate end of the transistor Q211, and the other end of the gate resistor RG211 is connected to the selection terminal P14.

[0061] The other end of the resistor R22 is connected to one end of the transistor Q22. One end of the gate

resistor RG22 is connected to the gate end of the transistor Q22, and the other end of the gate resistor RG22 is connected to the selection terminal P12. One end of the transistor Q221 is connected to one end of the capacitor C22. One end of the gate resistor RG221 is connected to the gate end of the transistor Q221, and the other end of the gate resistor RG221 is connected to the selection terminal P15.

[0062] The other end of the resistor R23 is connected to one end of the transistor Q23. One end of the gate resistor RG23 is connected to the gate end of the transistor Q23, and the other end of the gate resistor RG23 is connected to the selection terminal P13. One end of the transistor Q231 is connected to one end of the capacitor C23. One end of the gate resistor RG231 is connected to the gate end of the transistor Q231, and the other end of the gate resistor RG231 is connected to the selection terminal P16.

[0063] The other end of the transistor Q21, the other end of the transistor Q211, the other end of the transistor Q22, the other end of the transistor Q221, the other end of the transistor Q23, and the other end of the transistor Q231 are connected to the node NN.

[0064] The other end of the capacitor C21, the other end of the capacitor C22, and the other end of the capacitor C23 are connected to the node to which the terminal P22 and the terminal P23 are connected.

[0065] The snubber circuit 120 according to the exemplary embodiment illustrated in FIG. 4 operates through at least one selected according to the configuration of the resistance box 20 among the plurality of resistors R21 to R23 and at least one selected according to the configuration of the resistance box 20 among the plurality of capacitors C21 to C23.

[0066] The resistance box 20 includes a plurality of individual resistance boxes 21 to 26. In FIG. 4, the resistance box 20 is illustrated as including six individual resistance boxes 21 to 26, and the number of selection terminals P11 to P16 is illustrated as six.

[0067] Each of a plurality of individual resistance boxes 21 to 26 may include a selection resistor. Alternatively, each of a plurality of individual resistance boxes 21 to 26 may be an open circuit. Hereinafter, a resistance box that does not include the selection resistor among the plurality of individual resistance boxes 21 to 26 will be described as being open.

[0068] Hereinafter, an exemplary embodiment of the individual resistance boxes 21 to 26 included in the resistance box 20 will be described with reference to FIG. 5.

[0069] FIG. 5 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

[0070] In the example of FIG. 5, the individual resistance box 21 includes the selection resistor RS1, the individual resistance box 25 includes the selection resistor RS5, and the remaining individual resistance boxes 22 to 24 and 26 do not include the selection

resistor.

[0071] The power supply voltage VCC supplied to the resistance box 20 may supply a current to a corresponding one of the plurality of selection terminals P11 to P16 (e.g., P11 and P15) through an individual resistance box (e.g., 21 and 25) including a selection resistor among the plurality of individual resistance boxes 21 to 26.

[0072] In the converter 1 using the snubber circuit 120 and the resistance box 20 of FIGS. 4 and 5, the transistor Q21 is turned on by the power supply voltage VCC supplied through the resistor RS1 and the resistor RG21, and the transistor Q221 is turned on by the power supply voltage VCC supplied through the resistor RS5 and the resistor RG221. The resistor R21 and the capacitor C22 are connected in parallel to the second power transistor Q2 by the transistor Q21 and the transistor Q221 being turned on.

[0073] By the transistor Q21 and the transistor Q221 being turned on, the resistance value of the snubber circuit 120 may be the resistance value of the resistor R21, and the capacitance of the snubber circuit 120 may be determined as the capacitance of the capacitor C22.

[0074] Also, in the converter 1 using the snubber circuit 120 of FIG. 4, the resistance value of the snubber circuit 120 may be determined as a composite resistance using a plurality of resistors, or the capacitance of the snubber circuit 120 may be determined as a composite capacitance using a plurality of capacitors.

[0075] Hereinafter, an exemplary embodiment of a resistance box that allows the snubber circuit 120 to have a composite resistance or a composite capacitance will be described with reference to FIGS. 6 and 7.

[0076] FIG. 6 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

[0077] In the example of FIG. 6, the individual resistance box 21 includes the selection resistor RS1, the individual resistance box 23 includes the selection resistor RS3, the individual resistance box 25 includes the selection resistor RS5, and the remaining individual resistance boxes 22, 24, and 26 do not include the selection resistor.

[0078] The power supply voltage VCC supplied to the resistance box 20 may supply a current to a corresponding selection terminal (e.g., P11, P13, and P15) among the plurality of selection terminals P11 to P16 through an individual resistance box (e.g., 21, 23, and 25) including a selection resistor among the plurality of individual resistance boxes 21 to 26.

[0079] In the converter 1 using the snubber circuit 120 and the resistance box 20 of FIGS. 4 and 6, the transistor Q21 is turned on by the power supply voltage VCC supplied through the resistor RS1 and the resistor RG21, the transistor Q23 is turned on by the power supply voltage VCC supplied through the resistor RS3 and the resistor RG23, and the transistor Q221 is turned on by the power supply voltage VCC supplied through the resistor RS5 and the resistor RG221. When the transistor

Q21, the transistor Q23, and the transistor Q221 are turned on, the resistor R21, the resistor R23, and the capacitor C22 are connected in parallel to the second power transistor Q2.

[0080] By the turn-on of the transistor Q21, the transistor Q23, and the transistor Q221, the resistance value of the snubber circuit 120 may be a parallel synthesis resistance value of the resistor R21 and the resistor R23, and the capacitance of the snubber circuit 120 may be determined as the capacitance of the capacitor C22.

[0081] FIG. 7 is a circuit diagram illustrating an example of a resistance box according to an exemplary embodiment.

[0082] In the example of FIG. 7, the selection resistor RS1 is included in the individual resistance box 21, the selection resistor RS5 is included in the individual resistance box 25, the selection resistor RS6 is included in the individual resistance box 26, and the selection resistor is not included in the remaining individual resistance boxes 22 to 24.

[0083] The power supply voltage VCC supplied to the resistance box 20 may supply a current to a corresponding selection terminal (e.g., P11, P15, and P16) among the plurality of selection terminals P11 to P16 through an individual resistance box (e.g., 21, 25, and 26) including a selection resistor among the plurality of individual resistance boxes 21 to 26.

[0084] In the converter 1 using the snubber circuit 120 and the resistance box 20 of FIGS. 4 and 7, the transistor Q21 is turned on by the power supply voltage VCC supplied through the resistor RS1 and the resistor RG21, the transistor Q221 is turned on by the power supply voltage VCC supplied through the resistor RS5 and the resistor RG221, and the transistor Q231 is turned on by the power supply voltage VCC supplied through the resistor RS6 and the resistor RG231. When the transistor Q21, the transistor Q221, and the transistor Q231 are turned on, the resistor R21, the capacitor C22, and the capacitor C23 are connected in parallel to the second power transistor Q2.

[0085] By the turn-on of the transistor Q21, the transistor Q221, and the transistor Q231, the resistance value of the snubber circuit 120 may be the resistance value of the resistor R21, and the capacitance of the snubber circuit 120 may be determined as the parallel synthesis capacitance of the capacitor C22 and the capacitor C23.

[0086] The snubber circuit 120 may include a plurality of resistors as illustrated in FIGS. 4 and 6, or may include a plurality of capacitors as illustrated in FIGS. 4 and 7. Alternatively, the snubber circuit 120 may include a resistance box in which the resistance box illustrated in FIG. 6 and the resistance box illustrated in FIG. 7 are combined to include a plurality of resistors and a plurality of capacitors.

[0087] Through the snubber circuit 120 according to an exemplary embodiment, noise that may be generated in the second power transistor Q2 may be reduced, and a

snubber value of the snubber circuit 120 installed in the IC 10 may be adjusted according to a configuration of a selection resistor included in the resistance box 20 located outside the IC 10. The snubber value may be adjusted outside the IC 10 to reduce the debugging time for noise removal.

Description of symbols

[0088]

1 : Converter

10 : Integrated Circuit

110 : Switch Control Circuit

120 : Snubber Circuit

121 : First Snubber

122 : Second Snubber

123 : Third Snubber

20 : Resistance Box

21, 22, 23, 24, 25, 26 : Individual Resistance Boxes

30 : Output Unit

Claims

1. An electric power converter comprising:

an integrated circuit (10) including at least one power transistor (Q1, Q2) and a snubber circuit (120) connected in parallel to the at least one power transistor (Q1, Q2); and

characterized in that

wherein the snubber circuit (120) includes at least two snubbers (121, 122, 123), and wherein each of the at least two snubbers (121, 122, 123) includes a resistor (R21, R22, R23), a transistor (Q21, Q22, Q23), and a capacitor (C21, C22, C23) connected in series, and

in that the electric power converter further comprises a resistance box circuit (20) comprising, for each snubber (121, 122, 123), an individual resistance box (21, 22, 23) connected to a gate of the transistor (Q21, Q22, Q23) of the respective one of the at least two snubbers (121, 122, 123) through a corresponding selection terminal (P11, P12, P13) of the integrated circuit (10) and connectable to a power supply voltage (VCC), wherein at least one of the individual resistance boxes (21) for the snubbers (121) includes a selection resistor, wherein each selection resistor is configured to connect the gate of the transistor (Q21, Q22, Q23) of the snubber (121) corresponding to the respective individual resistance box (21) to the power supply voltage (VCC) to turn on the transistor (Q21) of said snubber (121) corresponding to the respective individual resistance box (21).

2. The electric power converter of claim 1, wherein at least one of the individual resistance boxes (22, 23) for the snubbers (122, 123) does not include a selection resistor, wherein each individual resistance box (22, 23) that does not include a selection resistor provides an open circuit between the gate of the transistor (Q22, Q23) of the snubber (122, 123) corresponding to the respective individual resistance box (22, 23) and the power supply voltage (VCC) thereby turning off the snubber (122, 123) corresponding to the respective individual resistance box (22, 23). 5 10
3. The electric power converter of claim 1 or 2, wherein: the integrated circuit (10) further includes a switch control circuit (110) configured to receive the power supply voltage (VCC) and control a switching operation of the at least one power transistor (Q1, Q2). 15
4. The electric power converter of one of claims 1 to 3, wherein the electric power converter is a DC-DC converter. 20
5. An electric power converter comprising: 25
 - an integrated circuit (10) including at a snubber circuit (120) connected in parallel with the at least one power transistor (Q1, Q2); and wherein the snubber circuit (120) includes:
 - at least two resistors (R21, R22, R23),
 - at least two first transistors (Q21, Q22, Q23),
 - at least two capacitors (C21, C22, C23), and
 - at least two second transistors (Q211, Q221, Q231) connected in series with each of the at least two capacitors (C21, C22, C23), respectively, and
- characterized in that**
 - the integrated circuit (10) further includes a power transistor (Q1, Q2);
 - the at least two first transistors (Q21, Q22, Q23) are connected in series with the at least two resistors (R21, R22, R23), respectively, and
 - wherein the electric power converter further comprises a resistance box circuit (20) comprising a plurality of individual resistance boxes (21-26) for the snubber circuit (120), wherein each individual resistance box of a first set of the individual resistance boxes (21, 22, 23) is connected to a gate of one of the first transistors (Q21, Q22, Q23) through a corresponding selection terminal (P11, P12, P13) of the integrated circuit (10) and connectable to a power supply voltage (VCC), and each individual resistance box of a second set of resistance boxes (24, 25, 26) is connected to a gate of one of the second transistors (Q211, Q221, Q231) through a corresponding selection terminal (P14, P15, P16) of the integrated circuit (10) and connectable to the power supply voltage (VCC), wherein at least two of the individual resistance boxes (21, 25) for the snubber circuit (120) include a selection resistor, wherein each selection resistor is configured to connect either the gate of one of the first transistors (Q21) or the gate of one of the second transistors (Q221) to the power supply voltage (VCC) through the selection resistor of the respective individual resistance box (21, 25) to thereby turn on the respective first transistor (Q21) or the respective second transistor (Q221), and wherein a first selection resistor of the at least two selection resistors (RS1) is connected to the gate of one of the first transistors (Q21) connected in series with any one of the at least two resistors (R21), and a second selection resistor of the at least two selection resistors (RS5) is connected to the gate of one of the second transistors (Q221) connected in series with any one of the at least two capacitors (C22). 30 35 40 45 50
6. The electric power converter of claim 5, wherein: wherein at least one of the individual resistance boxes (22, 24) for the snubber circuit (120) does not include a selection resistor, wherein each individual resistance box (22, 24) that does not include a selection resistor provides an open circuit between the gate of the first transistor (Q22) corresponding to the respective individual resistance box (22) and the power supply voltage (VCC) or between the gate of the second transistor (Q211) corresponding to the respective individual resistance box (24) and the power supply voltage (VCC) thereby turning off the respective first transistor (Q22) or respective second transistor (Q211) corresponding to the respective individual resistance box (22, 24). 55
7. The electric power converter of claim 5 or 6, wherein: the integrated circuit (10) further includes a switch control circuit (110) configured to receive the power supply voltage (VCC) to control the at least one power transistor (Q1, Q2). 50
8. The electric power converter of one of claims 5 to 7, wherein: a resistance value of the snubber circuit (120) is a parallel synthesis resistance of at least two of the at least two resistors (R21, R22, R23). 55
9. The electric power converter of one of claims 5 to 8,

wherein:

the at least two selection resistors further include a third selection resistor that is connected to a gate of one of the second transistors (Q231) 5
connected in series to another one of the at least two capacitors (C23), and
a capacitance value of the snubber circuit (120) is a parallel synthesis capacitance of one of the 10
at least two capacitors (C22) and another one (C23).

10. The electric power converter of one of claim 5 to 9, wherein the electric power converter is a DC-DC converter. 15

Patentansprüche

1. Elektrischer Leistungswandler, aufweisend: 20

eine integrierte Schaltung (10) mit mindestens einem Leistungstransistor (Q1, Q2) und einer Snubber-Schaltung (120), die parallel zu dem mindestens einen Leistungstransistor (Q1, Q2) 25
geschaltet ist; und

dadurch gekennzeichnet, dass

die Snubber-Schaltung (120) mindestens zwei Snubber (121, 122, 123) aufweist, und 30
jeder der mindestens zwei Snubber (121, 122, 123) einen Widerstand (R21, R22, R23), einen Transistor (Q21, Q22, Q23) und einen Kondensator (C21, C22, C23) aufweist, die in Reihe geschaltet sind, und

der elektrische Leistungswandler ferner eine Widerstandskastenschaltung (20) aufweist, die für jeden Snubber (121, 122, 123) einen individuellen Widerstandskasten (21, 22, 23) aufweist, der mit einem Gate des Transistors (Q21, Q22, Q23) des jeweiligen der mindestens zwei Snubber (121, 122, 123) durch einen entsprechenden Auswahlanschluss (P11, P12, P13) der integrierten Schaltung (10) verbunden ist und mit einer Leistungsversorgungsspannung (VCC) verbindbar ist, 35

wobei mindestens einer der individuellen Widerstandskästen (21) für die Snubber (121) einen Auswahlwiderstand aufweist, wobei jeder Auswahlwiderstand konfiguriert ist, das Gate des Transistors (Q21, Q22, Q23) des Snubber (121), der dem jeweiligen individuellen Widerstandskasten (21) entspricht, mit der Leistungsversorgungsspannung (VCC) zu verbinden, um den Transistor (Q21) des Snubber (121), der dem jeweiligen individuellen Widerstandskasten (21) entspricht, einzuschalten. 40 45 50 55

2. Elektrischer Leistungswandler nach Anspruch 1,

wobei mindestens einer der individuellen Widerstandskästen (22, 23) für die Snubber (122, 123) keinen Auswahlwiderstand aufweist, wobei jeder individuelle Widerstandskasten (22, 23), der keinen Auswahlwiderstand aufweist, einen offenen Stromkreis zwischen dem Gate des Transistors (Q22, Q23) des Snubber (122, 123), der dem jeweiligen individuellen Widerstandskasten (22, 23) entspricht, und der Leistungsversorgungsspannung (VCC) bereitstellt, wodurch der Snubber (122, 123), der dem jeweiligen individuellen Widerstandskasten (22, 23) entspricht, ausgeschaltet wird.

3. Elektrischer Leistungswandler nach Anspruch 1 oder 2, wobei: 15

die integrierte Schaltung (10) ferner eine Schaltsteuerschaltung (110) aufweist, die konfiguriert ist, die Leistungsversorgungsspannung (VCC) zu empfangen und einen Schaltvorgang des mindestens einen Leistungstransistors (Q1, Q2) zu steuern.

4. Elektrischer Leistungswandler nach einem der Ansprüche 1 bis 3, wobei der elektrische Leistungswandler ein DC-DC-Wandler ist.

5. Elektrischer Leistungswandler, aufweisend:

eine integrierte Schaltung (10) mit mindestens einer Snubber-Schaltung (120), die parallel zu dem mindestens einen Leistungstransistor (Q1, Q2) geschaltet ist; und 20
die Snubber-Schaltung (120) aufweist:

mindestens zwei Widerstände (R21, R22, R23),
mindestens zwei erste Transistoren (Q21, Q22, Q23),
mindestens zwei Kondensatoren (C21, C22, C23), und

mindestens zwei zweite Transistoren (Q211, Q221, Q231), die jeweils in Reihe mit jedem der mindestens zwei Kondensatoren (C21, C22, C23) geschaltet sind, und

dadurch gekennzeichnet, dass

die integrierte Schaltung (10) ferner einen Leistungstransistor (Q1, Q2) aufweist; die mindestens zwei ersten Transistoren (Q21, Q22, Q23) jeweils in Reihe mit den mindestens zwei Widerständen (R21, R22, R23) geschaltet sind, und

wobei der elektrische Leistungswandler ferner eine Widerstandskastenschaltung (20) aufweist, die mehrere individuelle Widerstandskästen (21-26) für die Snubber-Schaltung (120) aufweist, wobei jeder individuelle Widerstandskasten eines ersten Satzes der individuellen Widerstandskästen (21, 22, 23) mit einem Gate eines der

- ersten Transistoren (Q21, Q22, Q23) durch einen entsprechenden Auswahlanschluss (P11, P12, P13) der integrierten Schaltung (10) verbunden ist und mit einer Leistungsversorgungsspannung (VCC) verbindbar ist, und jeder individuelle Widerstandskasten eines zweiten Satzes von Widerstandskästen (24, 25, 26) mit einem Gate eines der zweiten Transistoren (Q211, Q221, Q231) durch einen entsprechenden Auswahlanschluss (P14, P15, P16) der integrierten Schaltung (10) verbunden ist und mit der Leistungsversorgungsspannung (VCC) verbindbar ist, wobei mindestens zwei der individuellen Widerstandskästen (21, 25) für die Snubber-Schaltung (120) einen Auswahlwiderstand aufweisen, wobei jeder Auswahlwiderstand konfiguriert ist, entweder das Gate eines der ersten Transistoren (Q21) oder das Gate eines der zweiten Transistoren (Q221) mit der Leistungsversorgungsspannung (VCC) durch den Auswahlwiderstand des jeweiligen individuellen Widerstandskastens (21, 25) zu verbinden, um dadurch den jeweiligen ersten Transistor (Q21) oder den jeweiligen zweiten Transistor (Q221) einzuschalten, und wobei ein erster Auswahlwiderstand der mindestens zwei Auswahlwiderstände (RS1) mit dem Gate eines der ersten Transistoren (Q21) verbunden ist, der in Reihe mit einem der mindestens zwei Widerstände (R21) geschaltet ist, und ein zweiter Auswahlwiderstand der mindestens zwei Auswahlwiderstände (RS5) mit dem Gate eines der zweiten Transistoren (Q221) verbunden ist, der in Reihe mit einem der mindestens zwei Kondensatoren (C22) geschaltet ist.
6. Elektrischer Leistungswandler nach Anspruch 5, wobei:
- wobei mindestens einer der individuellen Widerstandskästen (22, 24) für die Snubber-Schaltung (120) keinen Auswahlwiderstand aufweist, wobei jeder individuelle Widerstandskasten (22, 24), der keinen Auswahlwiderstand aufweist, einen offenen Stromkreis zwischen dem Gate des ersten Transistors (Q22), der dem jeweiligen individuellen Widerstandskasten (22) entspricht, und der Leistungsversorgungsspannung (VCC) oder zwischen dem Gate des zweiten Transistors (Q211), der dem jeweiligen individuellen Widerstandskasten (24) entspricht, und der Leistungsversorgungsspannung (VCC) bereitstellt, wodurch der jeweilige erste Transistor (Q22) oder der jeweilige zweite Transistor (Q211), der dem jeweiligen individuellen Widerstandskasten

(22, 24) entspricht, ausgeschaltet wird.

7. Elektrischer Leistungswandler nach Anspruch 5 oder 6, wobei:
- die integrierte Schaltung (10) ferner eine Schaltsteuerschaltung (110) aufweist, die konfiguriert ist, die Leistungsversorgungsspannung (VCC) zu empfangen, um den mindestens einen Leistungstransistor (Q1, Q2) zu steuern.
8. Elektrischer Leistungswandler nach einem der Ansprüche 5 bis 7, wobei:
- ein Widerstandswert der Snubber-Schaltung (120) ein paralleler Synthesewiderstand von mindestens zwei der mindestens zwei Widerstände (R21, R22, R23) ist.
9. Elektrischer Leistungswandler nach einem der Ansprüche 5 bis 8, wobei:
- die mindestens zwei Auswahlwiderstände ferner einen dritten Auswahlwiderstand aufweisen, der mit einem Gate eines der zweiten Transistoren (Q231) verbunden ist, der in Reihe mit einem anderen der mindestens zwei Kondensatoren (C23) geschaltet ist, und ein Kapazitätswert der Snubber-Schaltung (120) eine parallele Synthesekapazität eines der mindestens zwei Kondensatoren (C22) und eines anderen (C23) ist.
10. Elektrischer Leistungswandler nach einem der Ansprüche 5 bis 9, wobei der elektrische Leistungswandler ein DC-DC-Wandler ist.

Revendications

1. Convertisseur électrique comprenant :

un circuit intégré (10) comprenant au moins un transistor de puissance (Q1, Q2) et un circuit amortisseur (120) connecté en parallèle à l'au moins un transistor de puissance (Q1, Q2) ; et

caractérisé en ce que

le circuit amortisseur (120) comprend au moins deux amortisseurs (121, 122, 123), et chacun des au moins deux amortisseurs (121, 122, 123) comprenant une résistance (R21, R22, R23), un transistor (Q21, Q22, Q23), et un condensateur (C21, C22, C23) connectés en série, et

en ce que le convertisseur électrique comprend en outre un circuit à boîte de résistance (20) comprenant, pour chaque amortisseur (121, 122, 123), une boîte de résistance individuelle (21, 22, 23) connectée à une grille du transistor (Q21, Q22, Q23) de l'amortisseur respectif des

- au moins deux amortisseurs (121, 122, 123) à travers une borne de sélection correspondante (P11, P12, P13) du circuit intégré (10) et connectable à une tension d'alimentation (VCC), au moins une des boîtes de résistance individuelles (21) pour les amortisseurs (121) comprenant une résistance de sélection, chaque résistance de sélection étant configurée pour connecter la grille du transistor (Q21, Q22, Q23) de l'amortisseur (121) correspondant à la boîte de résistance individuelle (21) respective à la tension d'alimentation (VCC) pour activer le transistor (Q21) dudit amortisseur (121) correspondant à la boîte de résistance individuelle (21) respective. 5 10 15
2. . Convertisseur électrique selon la revendication 1, au moins une des boîtes de résistance individuelles (22, 23) pour les amortisseurs (122, 123) ne comprenant pas une résistance de sélection, chaque boîte de résistance individuelle (22, 23) ne comprenant pas une résistance de sélection comportant un circuit ouvert entre la grille du transistor (Q22, Q23) de l'amortisseur (122, 123) correspondant à la boîte de résistance individuelle (22, 23) respective et à la tension d'alimentation (VCC), et désactivant ainsi l'amortisseur (122, 123) correspondant à la boîte de résistance individuelle (22, 23) respective. 20 25 30
3. . Convertisseur électrique selon la revendication 1 ou 2, le circuit intégré (10) comprenant en outre un circuit de commande de commutateur (110) configuré pour recevoir la tension d'alimentation (VCC) et commander une opération de commutation de l'au moins un transistor de puissance (Q1, Q2). 35 40
4. . Convertisseur électrique selon une des revendications 1 à 3, le convertisseur électrique étant un convertisseur continu-continu. 45
5. . Convertisseur électrique comprenant : 45 50
- un circuit intégré (10) comprenant un circuit amortisseur (120) connecté en parallèle à l'au moins un transistor de puissance (Q1, Q2) ; et le circuit amortisseur (120) comprenant :
- au moins deux résistances (R21, R22, R23), 55
- au moins deux premiers transistors (Q21, Q22, Q23),
- au moins deux condensateurs (C21, C22, C23), et
- au moins deux deuxièmes transistors (Q211, Q221, Q231) connectés en série à

chacun des au moins deux condensateurs (C21, C22, C23), respectivement, et **caractérisé en ce que** le circuit intégré (10) comprend en outre un transistor de puissance (Q1, Q2) ; les au moins deux premiers transistors (Q21, Q22, Q23) sont connectés en série aux au moins deux résistances (R21, R22, R23), respectivement, et le convertisseur électrique comprend en outre un circuit à boîte de résistance (20) comprenant une pluralité de boîtes de résistance individuelles (21 - 26) pour le circuit amortisseur (120), chaque boîte de résistance individuelle d'un premier jeu de boîtes de résistance individuelles (21, 22, 23) étant connectée à une grille d'un des premiers transistors (Q21, Q22, Q23) à travers une borne de sélection correspondante (P11, P12, P13) du circuit intégré (10) et connectable à une tension d'alimentation (VCC), et chaque boîte de résistance individuelle d'un deuxième jeu de boîtes de résistance (24, 25, 26) étant connectée à une grille d'un des deuxièmes transistors (Q211, Q221, Q231) à travers une borne de sélection correspondante (P14, P15, P16) du circuit intégré (10) et connectable à la tension d'alimentation (VCC), au moins deux des boîtes de résistance individuelles (21, 25) pour le circuit amortisseur (120) comprenant une résistance de sélection, chaque résistance de sélection étant configurée pour connecter soit la grille d'un des premiers transistors (Q21), soit la grille d'un des deuxièmes transistors (Q221) à la tension d'alimentation (VCC) à travers la résistance de sélection de la boîte de résistance individuelle (21, 25) respective pour activer ainsi le premier transistor (Q21) respectif ou le deuxième transistor (Q221) respectif, et une première résistance de sélection des au moins deux résistances de sélection (RS1) étant connectée à la grille d'un des premiers transistors (Q21) connectés en série à une quelconque des au moins deux résistances (R21), et une deuxième résistance de sélection des au moins deux résistances de sélection (RS5) étant connectée à la grille d'un des deuxièmes transistors (Q221) connectés en série à un quelconque des au moins deux condensateurs (C22).

6. . Convertisseur électrique selon la revendication 5, au moins une des boîtes de résistance individuelles (22, 24) pour le circuit amortisseur (120) ne comprenant pas une résistance de sélection, chaque boîte

de résistance individuelles (22, 24) qui ne comprend pas une résistance de sélection fournissant un circuit ouvert entre la grille constituant un circuit ouvert entre la grille du premier transistor (Q22) correspondant à la boîte de résistance individuelle (22) respective et la tension d'alimentation (VCC), ou entre la grille du deuxième transistor (Q211) correspondant à la boîte de résistance individuelle (24) respective et la tension d'alimentation (VCC), en désactivant ainsi le premier transistor (Q22) respectif ou le deuxième transistor (Q211) respectif correspondant à la boîte de résistance individuelle (22, 24) respective.

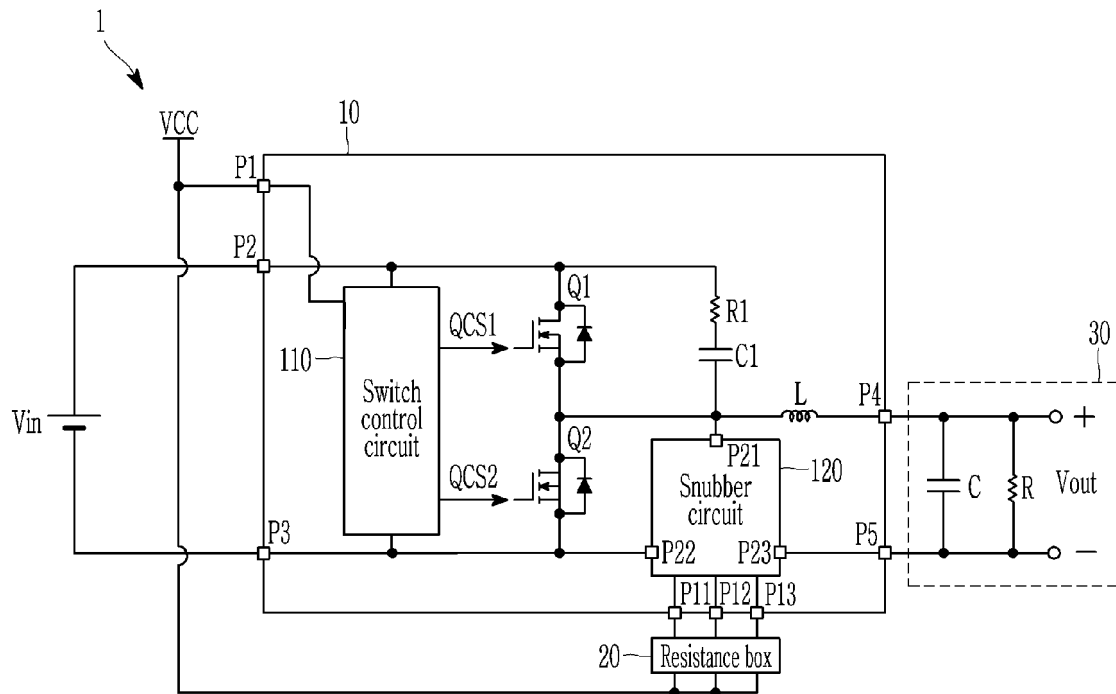
7. . Convertisseur électrique selon la revendication 5 ou 6,
le circuit intégré (10) comprenant en outre un circuit de commande de commutateur (110) configuré pour recevoir la tension d'alimentation (VCC) pour commander une opération de commutation de l'au moins un transistor de puissance (Q1, Q2).
8. . Convertisseur électrique selon une des revendications 5 à 7,
une valeur de résistance du circuit amortisseur (120) étant une résistance de synthèse parallèle d'au moins deux des au moins deux résistances (R21, R22, R23).
9. . Convertisseur électrique selon une des revendications 5 à 8,
les au moins deux résistances de sélection comprenant en outre une troisième résistance de sélection connectée à une grille d'une des deuxièmes résistances (Q231) connectées en série à une autre des au moins deux condensateurs (C23), et une valeur de capacitance du circuit amortisseur (120) étant une capacitance de synthèse parallèle d'un des au moins deux condensateurs (C22) et un autre (C23).
10. . Convertisseur électrique selon une des revendications 5 à 9, le convertisseur électrique étant un convertisseur continu-continu.

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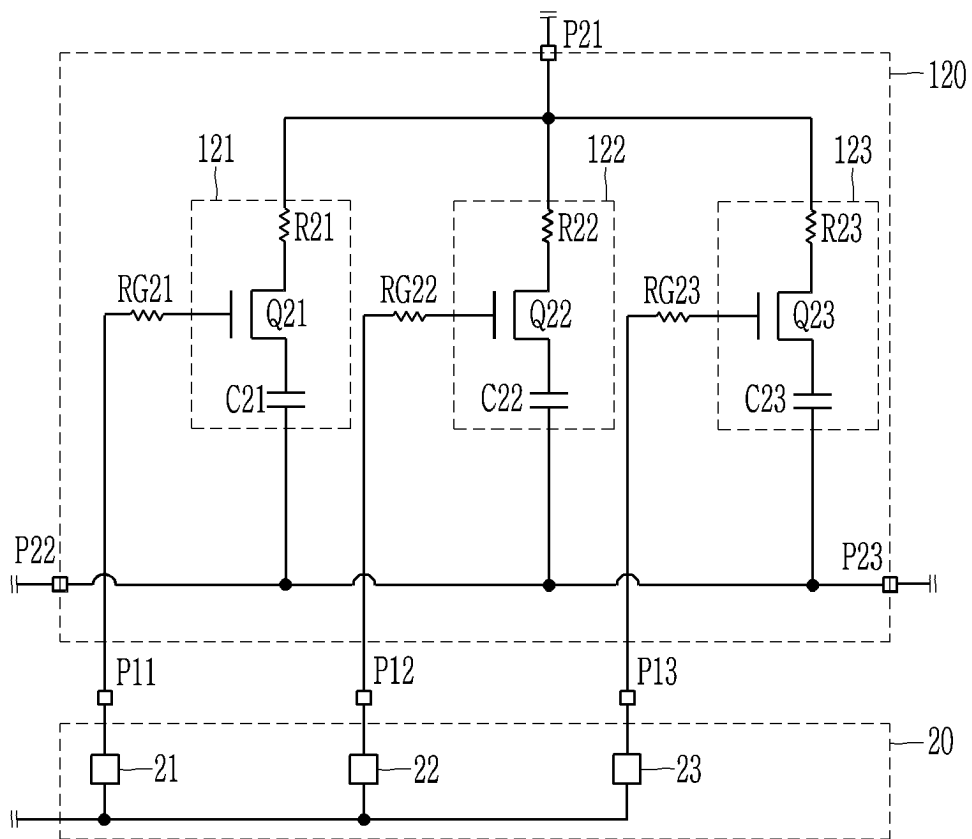
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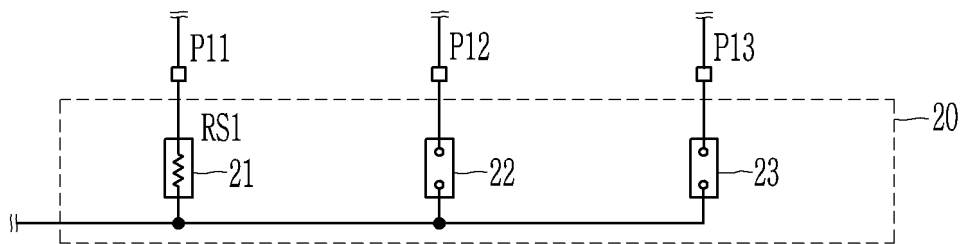
【Figure 1】



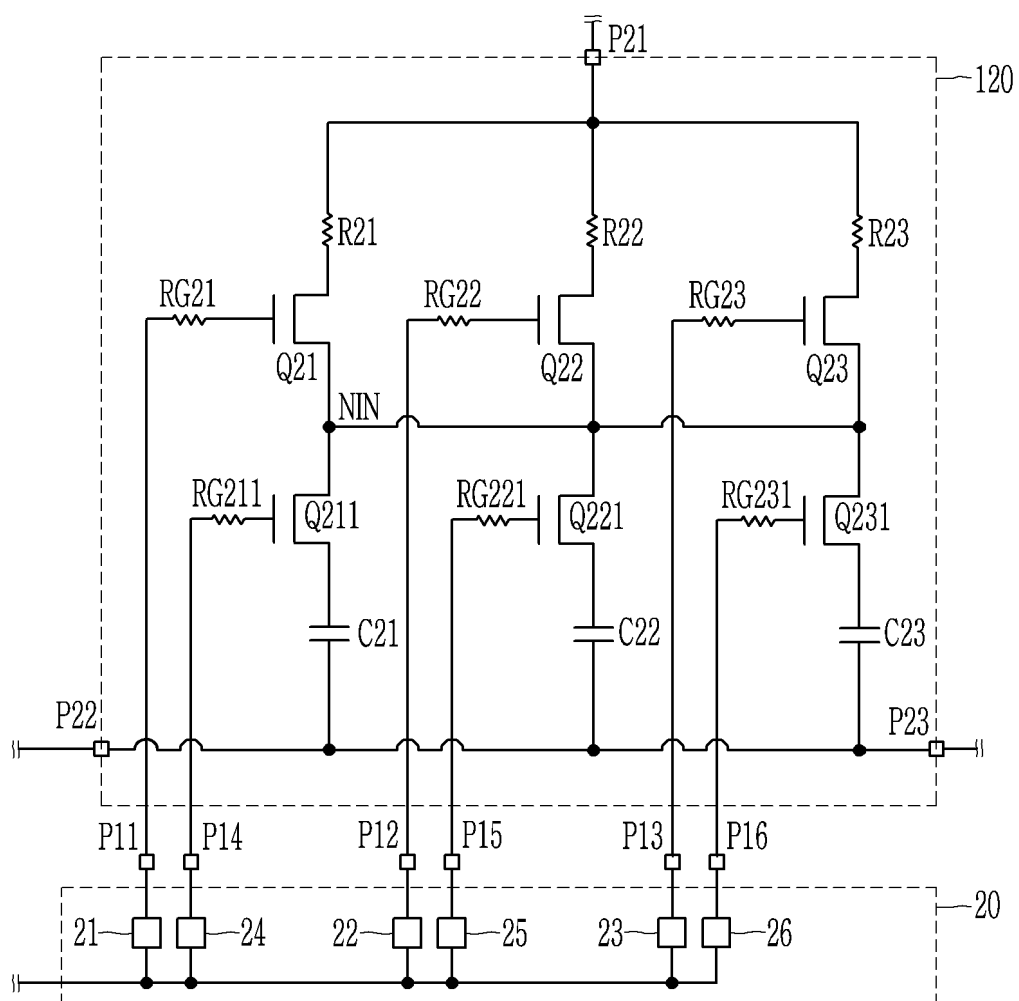
【Figure 2】



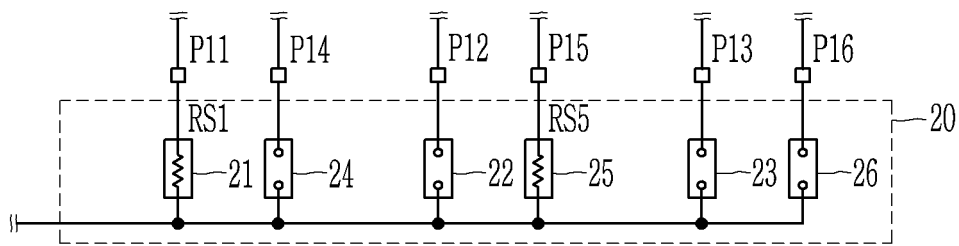
【Figure 3】



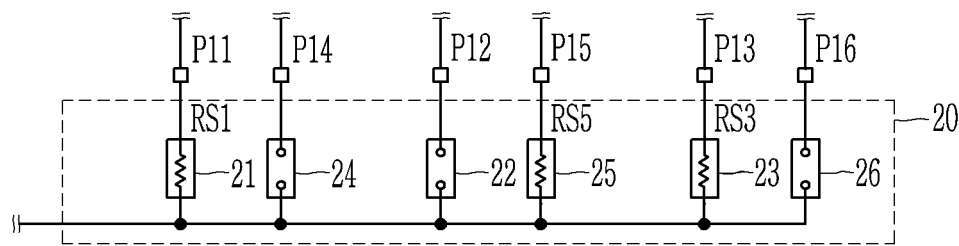
【Figure 4】



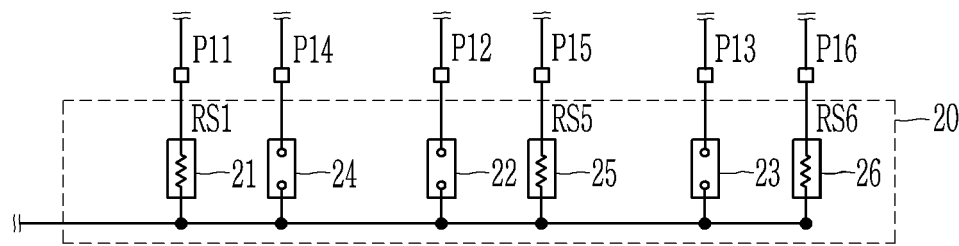
【Figure 5】



【Figure 6】



【Figure 7】



REFERENCES CITED IN THE DESCRIPTION

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